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ABSTRACT

Previous studies have documented the effectiveness of feedback in improving students' achievement, but few studies have examined the effectiveness of summaries or reviews. This study examines the respective and combined effects of feedback and review on students' achievement, retention, and level of cognitive development. A total of 55 ninth-grade students comprised five treatment groups which received an interactive slide/sound computer earth science lesson on "The History of the Earth." All groups received 26 self-test questions throughout the program. The control group received no feedback to their responses to the self-test questions and no reviews for each of the seven sections of the program. One group received non-content feedback for the responses and no reviews, a second group received content feedback and no reviews, a third group received non-content feedback and reviews; and the fourth group received content feedback and reviews. All subjects were given a 28-item achievement test immediately following the computer treatment and the same achievement test one week later. The study concluded that providing students with feedback produced significant increases in achievement, retention, and higher-order learning while a review produced significant improvement only in higher-order learning. (Author/CW)

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THE EFFECTS OF SLIDE/SOUND COMPUTER BASED INSTRUCTION ON STUDENTS' ACHIEVEMENT AND RETENTION

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ABSTRACT

Previous studies have documented the effectiveness of feedback in improving students' achievement, but few studies have examined the effectiveness of summaries or reviews. This study examines the respective and combined effects of feedback and review on students achievement, retention, and level of cognitive development.

A total of 55 ninth-grade students comprised five treatment groups which received an interactive slide/sound computer earth science lesson on The History of the Earth. All groups received 26 self-test questions throughout the program. The control group received no feedback to their responses to the self-test questions, and no reviews for each of the seven sections of the program. One group received non-content feedback for the responses and no reviews, a second group received content feedback and no reviews, a third group received non-content feedback and reviews, and the fourth group recieved content feedback and reviews. All subjects were given a 28 item achievement test immediately following the computer treatment and the same achievement test one week later.

Results indicated that

1. For the main effect, content feedback produced better results than reviews and reviews produced better results than no feedback or reviews on students achievement and retention. (Combined content feedback and reviews produced highest, but not significantly different, means.)

2. Achievement and retention differrence were attributable to the higher cognitive level questions; no treatment effects resulted from low cognitive level items. Higher level self-test questions provided a predictability for retention.

3. Although the amount of informational feedback increased the students' program time proportionately, productivity was significantly greatest for content feedback.

The study concluded that providing students with feedback produced significant increases in achievement, retention, and higher-order learning while a review produced significant improvement only in higher-order learning.

The study suggests interesting implications for the efficiency of the interactive form of science instruction and the impact of higher cognitive level feedback on retention.

THE EFFECTS OF SLIDE/SOUND COMPUTER-BASED INSTRUCTION ON STUDENTS' ACHIEVEMENT AND RETENTION

Purpose

The importance of feedback in classroom situations has been firmly established in the literature. According to Briggs (1977), it has been shown that learning from print materials can be enhanced by providing "self-test" questions which learners respond to before taking a different test over the objectives of the lesson. Reinforcement of learning should be immediate and systemitized, and this should result in more effective learning (Chambers and Sprecher, 1974). Research by Ellis, Kinoske, Wolfect, and Montague (1982), Surber and Anderson (1975), Morgan (1961), and Gaynor (1981), to name a few, have all indicated the importance of feedback in enhancing learning.

Feedback is used, in a generic sense, to describe any of the numerous procedures that are used to tell a learner if an instructional response is right or wrong. It ranges along a continuum from the simpliest yes-no format to the presentation of substantial or corrective remedial information that may extend the response context or even add new material to it (Kulhavey, 1977).

Review, more commonly given when a tutorial is about to end permanently, provides summary statements about the information in the lesson. A summary might be a list of major points or a paragraph summing up the purpose of the lesson (Alessi and Trollip, 1985). Gaynor (1981), indicates that end of session feedback, in essence a review, also facilitates learning more abstract and conceptual material in which the learner must apply higher-order thinking skills. Lastly, end of session feedback seems to facilitate long-term retention, especially with high mastery students.

Will the effects of feedback and/or review enhance students' learning and retention when used in a computer program? The purpose of this study is to

examine the effects on learning of varying feedback and review in an interactive slide/sound computer earth science lesson on "The History of the Earth."

Procedures

The hardware utilized in this study consisted of an Apple IIe computer with a color monitor and two disk drives and a Bell and Howell Ringmaster slide/sound projector. The slide/sound projector, which is interfaced with the computer, has the capability of projecting a series of 2" x 2" slides from a tray onto a screen located on the front of the projector while at the same time playing a cassette tape containing an audio script describing each slide.

The interactive earth science lesson consisted of 78 color slides depicting various plants and animals and illustrations of the appearance of the North American continent during each geologic period of the earth's history. The central theme of the lesson was the development of the earth and its living organisms through time. The audio script on the cassette tape provided students with a running commentary on how the earth was developing by discussing the scenes or illustrations on each slide. The program was divided into seven sections and at the end of each section students were asked, on the computer, a number of multiple choice self-help questions concerning the material in the section. There were 26 of these self-help questions in the program. After answering each question, students were then given non-content (knowledge of results) feedback or content (informational) feedback, by the computer, in response to their answers. Some students were also given a review at the end of each section. The slides, audio description, questions, feedback and review were scrutinized by four experts in the field and found to have a high content validity. Using the Kuder-Richardson 20 formula, the reliability of the self-help questions was found to be 0.7104.

After completion of the earth science lesson, students took a paper and pencil achievement test consisting of 28 multiple choice questions similiar to the self-help questions. These items determined the students' understanding of the development of the earth throughout its history as discussed in the computer lesson. Of these 28 achievement items, 8 were judged to be lower-order questions (knowledge and comprehension level) while 20 items were judged to be higher-order questions (application level and above). Using the Kuder-Richardson 20 formula, the reliability of these achievement questions was found to be 0.7130.

The population consisted of 55 ninth-grade earth science students from one high school located in a rural Pennsylvania school district. An earlier pilot study was conducted at a neighboring high school in the same school district to establish the reliability of the self-help questions and the achievement instrument used in the study. There were 44 ninth-grade earth science students that participated in this pilot study.

In the reported study, the 55 students were randomly assigned to one of five treatment groups as shown below:

	NF	NCF	CF
NR	0	I	II
R		III	IV

Figure 1. Research Design of Earth Science Lesson

One group (Cell I) received non-content feedback (NCF) which told the students only if their responses to the self-help questions were correct or incorrect. They also received no review (NR) at the end of each section. One group (Cell II) recieved content feedback (CF) which told them why their

answer was correct or incorrect and also received no review at the end of each section. One group (Cell III) received non-content feedback but had a review (R) at the end of each section. The final group (Cell IV) had content feedback and a review. A control group (Cell 0) received no feedback except "Thank You For Your Answer" and had no review at the end of each section.

Arrangements were made for each student to leave his/her earth science class and come to a science trailer adjacent to the school. There they individually ran through the earth science computer lesson, viewing the slides and listening to the description, answering the self-help questions, and receiving feedback and/or review according to the treatment group they were placed in. The program required an average of about 45 minutes to complete. Upon completion of the computer lesson, each student moved to a different part of the trailer where he/she took the achievement test which took about 15 minutes to finish. Because of total cooperation of the administration and faculty, the students had no problem leaving class or returning to class after completing the lesson and test.

After a one week delay, the same achievement test was administered to the participants as a retention test. This test was given in the library so the participating students left their earth science class and were given the test all at once. As before, the test took approximately 15 minutes to complete after which all students returned to their earth science class.

Results

Means and standard deviations for each of the five cells, according to low-level, high-level, and total questions correctly answered, follow in Table 1.

Table 1

Low-Level, High-Level, Total Mean Scores and Standard Deviations for Achievement and Retention Tests by Treatment

	Achievement Test			Retention Test		
	LL (n=8)	HL (n=20)	Total (n=28)	LL (n=8)	HL (n=20)	Total (n=28)
NF - NR (control)	4.78 (0.90)	6.49 (1.86)	11.27 (2.24)	3.91 (0.94)	6.91 (1.64)	10.82 (3.76)
NCF - NR	5.18 (1.25)	8.73 (3.74)	13.91 (4.09)	4.18 (0.98)	7.37 (2.42)	11.55 (2.70)
CF - NR	5.64 (1.03)	12.91 (3.62)	18.55 (3.98)	4.18 (0.98)	11.27 (3.23)	15.45 (3.19)
NCF - R	4.72 (1.35)	11.64 (4.25)	13.36 (4.52)	4.09 (0.70)	10.73 (3.90)	14.82 (4.24)
CF - R	5.27 (1.01)	13.82 (3.74)	19.09 (3.51)	4.09 (0.30)	12.64 (3.56)	16.73 (3.69)
Mean	5.12 (1.11)	10.72 (3.44)	15.84 (3.83)	4.09 (0.78)	9.78 (2.95)	13.87 (1.87)

As can be seen from table 1 above, the group that received content feedback and had reviews scored better than the other groups in both acheivement and retention test scores, while the group that received content feedback but had no reviews scored slightly lower but better than the other groups.

The achievement test scores and retention test scores were analyzed using a multiple analysis of variance (MANOVA) program found on a main-frame SPSS statistical package. These results appear in Tables 2 and 3.

Table 2

Summary of MANOVA Results of
Achievement Test Scores

Tests of Significance for Main Effects Using Sequential Sums of Squares

SOURCE	DF	MS	F	P
Review	1	590.945	1.194	0.281
Feedback	1	3797.195	7.670	0.008*
Review/Feedback	1	268.768	0.542	0.466
Error	40	495.057		
Total	43			

*$F_{.01} = 7.31$

The results from Table 2 indicate that content feedback performed better than non-content feedback on achievement test scores. However, there was no significant difference between review and no review performances and no significant interaction.

Table 3

Summary of MANOVA Results for
Achievement versus Retention Test Scores

Tests of Significance for Retention Using Sequential Sums of Squares

SOURCE	DF	MS	F	P
Retention	1	4177.876	124.946	<0.001**
Review x Retention	1	92.365	2.726	0.104
Feedback x Retention	1	140.945	4.215	0.047*
Rev x Feedbk x Ret	1	2.876	0.086	0.711
Error	40	33.438		
Total	44			

*$F_{.05} = 4.08$ **$F_{.001} = 12.6$

The MANOVA results from Table 3 indicate that content feedback performed better than non-content feedback on retention test scores. Review versus no review test scores were not significantly different. There was a very significant difference between the achievement test results and the retention test results which indicates that test scores dropped about the same for all treatment groups between achievement and retention tests.

An interesting development occurs when type of learning (low-level versus high-level) is analyzed.

Table 4

Summary of MANOVA Results for Low-Level versus High-Level Types of Learning

Tests of Significance for Types of Learning Using Sequential Sums of Squares

SOURCE	DF	MS	F	P
Type of Learning	1	294.070	0.799	0.377
Review x Type	1	2028.445	5.511	0.024*
Feedback x Type	1	1672.195	4.543	0.039*
Rev x Feedbk x Type	1	334.126	0.908	0.346
Error	40	368.068		
Total	44			

*$F_{.05} = 4.08$

Table 4 indicates that feedback and review both affect types of learning on achievement test scores. When averaging the total means for feedback on achievement tests, it was found that there was a gain of only 0.25 low-level questions correctly answered between non-content feedback and content feedback treatments but a dramatic gain of 3.05 high-level questions correctly answered between non-content and content feedback treatments. When the total means for review were averaged, there was a difference of only 0.26 low-level questions correctly answered between no review and review treatments but a dramatic increase of 2.14 questions correctly answered between no review and

review. These results indicate that both feedback and review will increase achievement in higher-order learning but neither feedback or review significantly increase lower-order learning.

The MANOVA analysis also indicated a significant difference in retention versus type of learning as shown in the following table:

Table 5

Summary of MANOVA Results for
Type of Learning versus Retention

Tests of Significance for Type of Learning vs Retention using Sequential Sums of Squares

SOURCE	DF	MS	F	P
Retention x Type	1	572.736	9.304	0.004*
Review x Ret x Type	1	12.820	0.028	0.651
Feedbk x Ret x Type	1	78.445	1.274	0.266
Error	40	61.536		
Total	43			

*$F_{.01} = 7.31$

When averaging the total means for type of learning versus retention, it was found that lower-level learning dropped by 1.36 questions correctly answered out of 8 total questions between the immediate achievement test and the retention test. It was also found that higher-level learning dropped by 1.28 questions correctly answered out of 20 total questions between the immediate achievement test and the retention test. These results indicate that students will retain higher-level learning much better than they will retain lower-level learning.

An interesting comparsion between the average time of completion of the computer program versus the average achievement scores can be made.

The following table indicated the time for completion of the computer program for each group or cell.

Table 6

Means and Standard Deviations for
Time of Completion of Computer Program
Across All Treatments [a]

	NCF	CF	
NR	44.09 (2.70)	45.55 (2.30)	44.82 (2.50)
R	45.91 (2.43)	50.82 (2.23)	48.36 (2.42)
	45.00 (2.57)	48.18 (2.27)	46.59 (2.42)

[a]Times given in Minutes

An interesting method for analyzing the effectiveness of each treatment was invented and is referred to as the productivity. The productivity of each cell might be defined as the mean time or completion of the computer program divided by the average cell score. This relationship of time/score is referred to as the number of minutes needed for each point or minutes/point. The following table lists the cell discription and the resulting productivity in minutes/point for both the immediate achievement test scores and retention test scores.

Table 7

Mean Productivity by Treatment
in Minutes/Point

	Achievement Test	Retention Test
NCF - NR	3.17	3.82
CF - NR	2.46	2.94
NCF - R	2.81	3.10
CF - R	2.66	3.04

As can be seen from Table 7, The CF - NR (cell II) has the lowest ratio of minutes/point and can be said to have the highest productivity. The next cell is CF - R (cell IV) which has the second lowest ratio of minutes/point and can be said to have the second highest productivity. This interesting relationship suggests that not only does feedback improve scores, it also provides the most efficient use of time.

Conclusions

One of the most important findings of the study is that feedback, especially content feedback, is of prime importance in increasing student achievement. These results should be expected; the more detailed feedback students receive, the better they should do on a similiar achievement test. As Gallini (1983) indicates, good feedback is essential for the cognitive development of students. It is interesting to note that since reviews are not significiant in increasing students' achievement feedback is the more important of the two treatments for improvement of achievement.

A second important effect the study pointed out is that feedback is also more important in increasing student retention than reviews.

A third, and one of the most important findings of the study was the effect feedback and review had on type of learning and the effect type of learning had on retention. When low-level questions were involved, neither feedback nor

review significantly affected achievement or retention. There was, however, a significant and important difference between feedback and high-level learning and review and high-level learning. These results dramatically point out the fact that both feedback and review are important in eliciting higher-level learning. Howe and Durr (1982) found that raising the cognitive level of students helped them in answering higher-level questions and they also stated that feedback helped raise this cognitive level in students. The analysis also pointed out the fact that type of learning affected retention. As expected, once students learn high-level concepts, skills, or theories, they are much more likely to retain both lower and higher-level information than if they learn only low-level factual information.

In summary, in the development of future classroom lessons or CBI software, teachers and programmers would be well advised to include some form of higher-level content feedback to insure better achievement, better retention, and better learning of higher-level concepts for their learners.

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